

- g. Furnish the written warranty
- 2. Turn over all spare parts to owner with documentation showing which instrument or control system the spare parts are for.

G. Schedule

- 1. Submit a detailed work schedule showing start/finish dates, task duration, task sequencing, critical path, and available float. Identify task predecessors and identify coordination activities with other trades.

H. Startup and Commissioning Plan

- 1. Submit a detailed startup and commissioning plan for review by Owner and Engineer. Plan should include the following information:
 - a. The order in which the various plant systems will be started up
 - b. What work must be performed prior to the startup
 - c. What documentation will be maintained by the contractor and provided to the owner validating that the startup was performed in a safe and efficient manner.

1.06 QUALITY ASSURANCE

A. Qualifications

- 1. Contractor performing the work shall have a minimum 5 years experience performing similar work in similar industries. All contractors' personnel shall be trained and experienced in best current construction practices.

B. Regulatory Requirements

- 1. Perform all work in accordance with all applicable national and local codes.

C. Certifications

- 1. Not applicable this section

D. Field Samples

- 1. Not applicable this section

E. Mock-Ups

- 1. Not applicable this section

F. Pre-Installation Meetings

- 1. Not applicable this section

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading

- 1. Perform these activities in a manner which assures instruments and equipment will arrive undamaged and in proper working order. Replace any instrument or equipment damaged upon arrival at no additional cost to owner.

B. Acceptance at Site

1. Maintain a comprehensive log by instrument or equipment tag number of all received instruments or equipment

C. Storage and Protection

1. Store all instruments and equipment as recommended by manufacturer. Protect from physical damage, moisture, dirt/dust, or extremes of temperature

1.08 PROJECT/SITE CONDITIONS

A. Environmental Requirements

1. Follow any and all environmental requirements pertaining to the site
2. Maintain a safe and clean job site
3. Dispose of all trash and construction debris in an approved manner

B. Existing Conditions

1. Contractor is to examine the site and be thoroughly familiar with any site requirements which may affect the work or storage of instruments or equipment.

1.09 SEQUENCING

- A. Coordinate all work with other trades.

1.10 SCHEDULING

- A. Provide and maintain a detailed schedule for performance of the work identifying start/finish dates, durations, required preceding activities, and coordination with other trades. Organize procurement, deliveries, and staff labor to meet the overall construction schedule and to assure that other trades are not delayed.

1.11 WARRANTY

A. Instrumentation

1. One year from system acceptance by owner for all discrete instrumentation, control devices, or equipment. During this period, replace any defective or malfunctioning device with 15 working days after notification by owner.
2. One year from system acceptance by owner for the performance of the overall control system. Correct the defect within 15 working days after notification by owner. Warranty repair work includes but is not limited to the following:
 - a. Improper sequencing or interlocking of equipment control systems
 - b. Wiring errors or omissions
 - c. Improper calibration of field instruments
 - d. Improper operation of programmable logic controllers or operator interface terminals
 - e. Improper operation of communications systems installed as part of the overall control system
 - f. Unsafe operations or maintenance conditions
 - g. Other system malfunctions which prevent or impair the plant from operating at design capacity, requires excessive operator intervention, or results in

unsafe operating conditions.

1.12 SYSTEM STARTUP/COMMISSIONING

A. General

1. Provide labor, tools, and equipment to start up the facility in a safe and efficient manner.
2. Plant shall be started up by system. A system is defined as a collection of mechanical, electrical, and controls equipment configured to perform a specific function or purpose. Examples may be a UV disinfection system, a dissolved oxygen blower system, a grit removal system, etc... The order in which the systems will be started shall be submitted by contractor in the startup plan and approved by owner and engineer. Any variance in this schedule must be approved by owner and engineer.
3. Unless approved otherwise by owner and engineer, contractor is to follow the startup sequence detailed below. The following work must be complete prior to beginning the startup:
 - a. All mechanical equipment installed and tested in accordance with manufacturers recommendations.
 - b. All motors must have been rotation checked.
 - c. Electrical power is available and wired to all mechanical equipment
 - d. All instruments must have been calibrated and installed in accordance with the manufacturer's recommendations.
 - e. Control system communication systems are installed and fully operational. This includes DH+ networks, Modbus+ networks, Ethernet networks, radio telemetry systems, telephone systems, etc...
 - f. All power and control wiring must be installed, rung out, and validated to be in accordance with approved construction drawings.
 - g. Programmable logic controllers, SCADA computers, and Operator Interface Terminals all are installed, have their programs installed, and these devices are fully operational and functioning in their design configuration.

B. System Startup Sequence

1. By manipulation of the instrument or direct signal injection at the instrument, verify that the control signal (discrete or analog) is received at the programmable logic controller or by the hard wired control circuit.
2. For motorized equipment, disconnect the power leads at the starter, VFD, or solid state motor controller.
3. Completely exercise the control circuit in Manual, Remote, and Automatic modes and verify that all interlocks and permissives are functioning correctly.
4. Verify that the programmable logic controller can start and stop the motor in Auto or Remote. Motors may be "bumped" by forcing PLC outputs but these program forces must be removed immediately afterward.
5. Verify that run status, signal levels, and alarms display properly on the OIT and the SCADA screens.
6. Reconnect the motor power leads.
7. Verify PID loop operating correctly (either direct or reverse) and adjust gain

- constants to achieve critically damped operation.
8. Configure the mechanical system for normal operation and leave system ready for normal operation.
 9. Utilize colored tagging scheme to identify startup condition. Red is not ready for startup, yellow is mechanically and electrically ready but not yet tested or started up, and green is fully tested and ready for normal operation. Place these tags on all mechanical, electrical, instrumentation, and control components of each system.
 10. As plant systems are started up, coordinate and remedy any coordination or interface issues between systems.

C. Remedies for Damages

1. Contractor is liable for any and all damage done to mechanical or electrical equipment due to improper startup procedures and shall repair or replace any damaged equipment at owner's discretion without additional cost to owner.
2. Contractor is forbidden to jumper around any process or safety interlock either with wiring or within a PLC program without the express written permission of both the owner and engineer. All jumpers, hardwired and programmed, must be maintained in a log book. Entries shall include:
 - a. Name of person placing the jumper
 - b. Date of installation
 - c. Reason for installation
 - d. Approval of owner and engineer
 - e. Date of removal
 - f. Name of person removing the jumper

1.13 OWNER'S INSTRUCTIONS

- A. Not applicable this section

1.14 MAINTENANCE

- A. Extra Materials
1. Not required this section
- B. Maintenance Service
1. Not required this section

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approved manufacturers are listed in the other Electrical and Instrument Specification Sections.

2.02 EXISTING PRODUCTS

- A. Not applicable this section

2.03 MATERIALS

- A. All materials are to be new and the manufacturers most current model.

2.04 MANUFACTURED UNITS

- A. Manufactured units are to be fully assembled and tested at the point of manufacture and delivered to the job site ready for installation and start-up.
- B. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of plus or minus 10 percent, and the supply output shall be fused or short circuit protected. Output voltage regulation shall be as required by the instrumentation equipment being supplied. Multi-loop, or multi-system power supplies, will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.
- C. The power distribution from multi-loop supplies shall be selectively fused such that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and located for easy access. Multi-loop supply systems shall be oversized for an additional 10 percent future load. Failure of a multi-loop supply shall be indicated on the respective instrument panel or enclosure.

2.05 EQUIPMENT

- A. All equipment is to be new and the manufacturers most current model. All instruments and control devices and assemblies shall be standard devices constructed of corrosion-resistant materials enclosed in a water and dust proof case and mounted as specified in the individual application. Enclosures shall be manufacturer's standard color unless specified otherwise.

2.06 COMPONENTS

- A. Not applicable this section

2.07 ACCESSORIES

- A. Not applicable this section

2.08 MIXES

- A. Not applicable this section

2.09 FABRICATION

- A. Shop Assembly
 - 1. Fabricate assemblies in accordance with approved drawings. Notify engineer and owner at least 5 working days prior to start of testing so that they may witness the testing if they choose to do so.

2.10 FINISHES

- A. General
 - 1. Finishes for all components, equipment, and fabricated assemblies must take into account the environment in which they will be installed. NEMA ratings must be appropriate for the environment. Ratings for corrosive areas must be NEMA 4X, for outdoor areas NEMA 4 or 3R, indoor dusty areas may be NEMA 12.
- B. Shop Finishing
 - 1. Where called for in other sections, sandblast, prime, and paint assemblies.

2.11 SOURCE QUALITY CONTROL

- A. Fabrication/Tolerances
 - 1. In accordance with generally accepted manufacturing standards
- B. Tests, Inspections
 - 1. In accordance with generally accepted manufacturing standards
- C. Verification of Performance
 - 1. Not applicable this section

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Contractors having a minimum 5 years experience in the design, procurement, and construction of industrial water/wastewater instrumentation and control systems.

3.02 EXAMINATION

- A. Site Verification of Conditions
 - 1. Visit job site and ascertain any environmental or physical conditions which may affect the performance of the work or the equipment requirements

3.03 PREPARATION

- A. Protection
 - 1. Not applicable this section
- B. Surface Preparation
 - 1. Not applicable this section

3.04 ERECTION

- A. Provide 4 inch tall reinforced concrete housekeeping pads for all control panels and floor mounted fabricated control assemblies and consoles. Dowel into concrete base and extend a minimum of 2" past edges of equipment.
- B. Provide unistrut or fabricated structural supports for heavy equipment or assemblies. Prime and paint supports so that they are unaffected by the environment in which they are installed.
- C. Securely fasten all panels and assemblies to their housekeeping pads or structural supports.
- D. All interconnecting wiring shall be run in conduit in accordance with the division 16 sections requirements.

3.05 INSTALLATION

- A. Install all instruments and controls in accordance with manufacturer's recommendations and all applicable electrical codes and standards. Connect all required utilities including electrical power, air, hydraulics, etc...
- B. Provide stainless steel tags for each instrument engraved with instrument tag number. Attach to instrument with stainless steel wire.
- C. Provide engraved nameplates for all panel mounted instruments. Attach to panel with stainless steel screws.

3.06 APPLICATION

- A. Not applicable this section

3.07 CONSTRUCTION

- A. Special Techniques
 - 1. In accordance with manufacturers recommended installation procedure
- B. Interface with Other Work
 - 1. Coordinate with all other trades
- C. Sequences of Operation
 - 1. Not applicable this section
- D. Site Tolerances
 - 1. Not applicable this section

3.08 REPAIR/RESTORATION

- A. Repair any damages caused by the installation or erection to original condition.

3.09 RE-INSTALLATION

- A. Not applicable this section.

3.10 FIELD QUALITY CONTROL

- A. Site Tests
 - 1. Test and calibrate instrumentation in accordance with other parts of this section
- B. Inspection
 - 1. Not required this section
- C. Manufacturer's Field Services
 - 1. If recommended by manufacturer, have equipment/control systems inspected, tested, and started up by manufacturer's representative.

3.11 ADJUSTING

- A. Not required this section

3.12 CLEANING

- A. Remove and dispose of construction debris daily. Wipe down and vacuum out all enclosures.

3.13 DEMONSTRATION/TRAINING

- A. In accordance with the Startup part of this section.
- B. Provide training of personnel in the operation and maintenance of the furnished control systems.
- C. Training shall be provided as required elsewhere in the Contract Documents, but shall consist of at least eight hours, in a single, or multiple sessions, to accommodate the personnel schedules.
- D. Coordinate with the Engineer, and the Owner, to schedule the training sessions at least 5 workings days in advance.

3.14 PROTECTION

- A. Protect instrumentation and control equipment from environmental damage and from damage by other trades.

3.15 SCHEDULES

- A. Not applicable this section.

End of Section

This page intentionally left blank

SECTION 17111

FLOAT SWITCHES

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes furnishing all float switches as indicated on the drawings and specified herein.
- B. Related work specified elsewhere includes, but is not limited to, Section 16000, Electrical. Also refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

- A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:
 - 1. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.
 - 2. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 BALL TYPE FLOAT WITH INTEGRAL MERCURY SWITCH AND ATTACHED CABLE.

- A. Float switch shall be direct acting and consist of a 316 type stainless steel housing, mounting clamp, a flexible three-conductor cable with a synthetic rubber jacket and a mercury switch. The float housing shall be a sphere of at least 4 1/2 inches in diameter.
- B. The mercury switch shall be embedded in a metal housing inside the float. The cable shall be 3/C #14, "SO" TYPE with 105 strands per conductor, made specifically for underwater use and heavy flexing service.

- C. The mercury switch shall be connected to two of the three conductors of the cable. The third conductor shall be an internal ground and shall be colored green. The switch shall have a 20 ampere rating at 115 volts AC.
- D. An additional synthetic rubber jacket shall act as a hinge between the float and where the cable is held by the stationary clamp. This clamp shall be stainless steel with an adapting fitting and two yokes for mounting on a vertical 1-inch pipe.
- E. A liquid rise of 1 inch from the reset position shall operate the float switch, and reset shall occur when the liquid level drops to 1 inch. Operating temperature shall be 0 degrees F to + 180 degrees F.
- F. Weight and buoyancy shall be such that contaminants like a cake of grease will not result in the float switch changing operating level more than 1 inch.
- G. A cast aluminum, NEMA 4 junction box shall be supplied for termination of the float cable(s), to allow conventional wiring and conduit to be run from the junction box to a control panel. It shall have terminal blocks for the required number of circuits and shall accept sealed fittings furnished with the float switch.
- H. Float switches shall be as manufactured by US Filter Model 9G, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment and materials specified in this section shall be installed and connected as specified and as shown on the drawings. Contractor shall coordinate with Mechanical and Structural for optimum location of float switches.

3.02 ACCEPTANCE

- A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications.

End of Section

SECTION 17122

LEVEL TRANSMITTERS - PRESSURE TYPE

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes furnishing Level Transmitters as shown on the Drawings and specified herein.
- B. Related work specified elsewhere includes, but is not limited to Section 16000, electrical. Also refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

- A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:
 - 1. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.
 - 2. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

1.04 MANUFACTURERS

- A. Level transmitter manufacturers shall be Bristol Babcock, Rosemount, Foxboro, ABB Kent-Taylor, or equal.

PART 2 - PRODUCTS

2.01 LEVEL TRANSMITTER

- A. Transmitters shall be of a two-wire type, 24 VDC powered by the signal loop, producing a 4 to 20 mA output proportional to the calibrated pressure range of the instrument. Transmitters shall be capable of driving a 500 ohm loop load.

- B. Instrument accuracy shall be within plus or minus 0.5 percent of span, and a 0.2 percent repeatability. Dead band shall be within 0.1 percent of span.

PART 3 - EXECUTION

A. INSTALLATION

- B. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations, and as shown on the Drawings. Contractor shall coordinate with other trades to insure proper connection to piping and other mechanical equipment.
- C. In areas prone to freezing, wrap all wetted parts of the instrument and piping with insulating material. Provide access to bleed valves and pipe fittings.

3.02 ACCEPTANCE

- A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation.

End of Section

SECTION 17150

LIMIT AND POSITION SWITCHES

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Position and proximity switches used to monitor equipment status and to detect security intrusion.
- B. Related Sections
 - 1. Other Division 16000 sections
 - 2. General Conditions for testing, adjusting and balancing of systems.

1.02 SYSTEM DESCRIPTION

1.03 SUBMITTALS

- A. In accordance with Section 16000, and elsewhere in the Contract Documents.
- B. Product Data
 - 1. Product information brochures, catalog cut sheets, other product literature containing manufacturers specifications, sizes, ratings, enclosure type and details, conditions-of-use, and fully developed part numbers.
- C. Reference standards shall be the latest edition, including addenda, supplements, and revision. Applicable reference publications include the following:
 - NEC
 - NEMA
- D. Quality Assurance/Control
 - 1. Manufacturers instructions for use.

1.04 QUALITY ASSURANCE

- A. Manufacturer must be regularly engaged in the design and manufacture of this type of equipment and shall assume responsibility for and guarantee performance of the equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the equipment.

PART 2 PRODUCTS

2.01 MANUFACTURES

- 1. Cutler Hammer

2. Square D

2.02 GENERAL

- A. Heavy duty, industrial grade units with NEMA rated housings compatible with installation location and environmental conditions. Enclosures to be NEMA 4X unless noted otherwise or provided as part of a packaged system.
- B. Electrical contact sets configured as shown on drawings and rated for 5 amps at 250 volts minimum. Electrical connections maximum #12 AWG copper wire and ½" conduit.
- C. Sensing elements must have provisions for field mechanical adjustment.

2.03 LIMIT SWITCHES - MECHANICAL

- A. Combination switch housing and position sensing lever coordinated with mechanical equipment whose position is to be sensed. Lever sensing arm to be rated for 10,000 mechanical operations.

2.04 LIMIT SWITCHES - PROXIMITY

- A. Integrated capacitive or inductive proximity sensing unit and switch housing. Coordinate sensing distance with mechanical equipment whose position is being sensed. Provide with adjustable mounting bracket compatible with the switch housing and environmental conditions.

2.05 LIMIT SWITCHES – PHOTO-ELECTRIC

- A. Combination switch housing with photo-electric sensor and separate photo-electric emitter or photo-electric reflective unit. Coordinate sensor style, beam intensity, and wavelength with mechanical equipment whose position is being sensed. Unit must operate reliably under all ambient light conditions. Power supply and contact ratings as shown on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install and connect as specified and shown on the drawings.
- B. Adjust position sensing elements for reliable and repeatable operation.
- C. Coordinate with Mechanical and other trades to insure proper connection to mechanical or other equipment.

3.02 ACCEPTANCE

- A. Certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's guarantee.

End of Section

This page intentionally left blank

EXHIBIT E
INSTRUMENTATION INDEX

DEVICE TAG #	DESCRIPTION	SPEC. #	MANUFACTURER/MODEL #
ZS-400A	RESERVOIR SITE GATE INTRUSION SWITCH	17150	SQUARE D, HEAVY DUTY INDUSTRIAL LIMIT
ZS-400B	RESERVOIR SITE GATE INTRUSION SWITCH	17150	SQUARE D, HEAVY DUTY INDUSTRIAL LIMIT
ZS-401	RESERVOIR NO. 1 INTRUSION SWITCH	17150	SQUARE D, HEAVY DUTY INDUSTRIAL LIMIT
MOTION SENSOR	SITE OCCUPANCY SENSOR	NA	LEVITON, PS200-10W
LIT-400	RESERVOIR NO. 1 TANK LEVEL TRANSMITTER	17122	ROSEMOUNT, 3051L PRESSURE TRANSMITTER
LSHH-400	RESERVOIR HIGH/HIGH LEVEL FLOAT SWITCH	17111	US FILTER, 9G DIRECT ACTING FLOAT SWITCH

ST-RH038063